Report for 2003DE24B: Undergraduate Internship: Enhanced Degradation of Benzoate by Electrode-Utilizing Microorganisms

- Water Resources Research Institute Reports:
  - Joslyn, Andrew, Steven Dentel, 2004, Enhanced Degradation of Benzoate by Electrode-Utilizing Microorganisms, Delaware Water Resources Center, University of Delaware, Newark, Delaware, 6 pages.

Report Follows

Undergraduate Internship Project #5 of 10 for FY03

The project is co-sponsored by the ***UD College of Engineering*** and the ***DWRC.*** Mr. Joslyn aims to explore wastewater reactor configurations that will optimize the growth of particular bacterial microorganisms responsible for biodegradation of water pollutants. This project is co-investigated by Kate Schutte (project **2003DE21B,** intern project #24 of 32 to date**)** and extends the work of 2002 ***DWRC*** interns Aditya Sharma and Bret Strogen (project **2002DE40B,** intern project #22 of 32 to date).

"If wastewater treatment plants could use my reactor's technology to more quickly biodegrade pollutants and additionally create a current that could be used to support other treatment activities, the effect on their efficiency would be profound."
-- Andrew Joslyn, University of Delaware undergraduate senior, Environmental Engineering major.

Abstract:

This study of electricity generation by microorganisms was conducted to determine whether or not biodegradation was enhanced by the presence of an electrode system. The results show that a reactor with a closed circuit was able to degrade 60.6% of the organic content, whereas a reactor with an open circuit only degraded 48.7%. In addition, the experiment showed a clear connection between the addition of benzoate and the production of an electric current. In one reactor, with a sodium benzoate concentration of about 3.8 g/L, the current production was much greater (peak at more than 800 microamps) than in another reactor with one-tenth the concentration of benzoate (peak at about 500 microamps). When 1 gram of sodium benzoate was spiked into the reactors after 69 days, the current production increased almost immediately.

Discussion

This experiment showed that current and voltage can be created and maintained by a mixed, anaerobic, sludge culture. The results of this experiment suggest that the degradation of organic materials can be enhanced by connecting a circuit between an anaerobic digestion compartment and an aerated chamber.

The current production seems to be limited by the available surface area of graphite electrode. This was shown when, periodically, one of the two circuits in a reactor was disconnected and the other was measured for current. In these cases, the current production through one electrode increased, but never equaled the sum of currents produced when both circuits were closed. Therefore, one can expect to see a greater rate of degradation of organic material when the surface area of graphite electrode is increased.

Conclusion

The major finding in this research was that the degradation of organic material was enhanced when the graphite electrode circuit was closed. This must mean that at least one organism gained an advantage by having the electrode available for electron shuttling.

The next steps in this research should be to determine the mechanism for electron transport, identify the organism(s) responsible for current production, and test various organic compounds to see if there is potential for enhanced degradation. For example, there are some pollutants common to surface and groundwater, such as TCE. If the degradation of TCE (or other

hazardous organic compounds) could be enhanced using an electrode system like the one designed in this experiment, there could be great implications for remediation projects around the world.